

**Iowa Department of Natural Resources  
Environmental Protection Commission**

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**ITEM**

**12**

**INFORMATION**

**TOPIC**

**Total Dissolved Solids (TDS) and Chloride Update**

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The current TDS site-specific criteria became effective in Iowa's Water Quality Standards (WQS) on June 16, 2004. The Commission instructed the department to gather more information over a three year period based on six formal recommendations published in Iowa Administrative Bulletin on April 14, 2004 as ARC 3281B. The department was further instructed to use this information to propose a new standard by April 1, 2007.

While the Commission is not being presented with a formal rule proposal, the department is moving forward with data analysis and criteria development reflecting the latest toxicity information. The department is actively working with other states and EPA to ensure reasonable and approvable methods for criteria development are pursued, to determine if there have been significant technological improvements in the treatment of TDS, and explore implementation alternatives. Technical advisory committee meetings will be utilized in the very near future to discuss the best approaches for TDS and Chloride criteria.

The Commission will be updated on the current progress, time lines, and latest information regarding TDS and Chloride rule development. The document "Status Report on TDS/Chloride" will provide more detailed information including a report on the extensive sampling project with IDNR and IWPCA, potential fiscal impacts, an overview of TDS, and updates on each of six EPC recommendations.

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February 8, 2007

## **Status Report on TDS/Chloride**

3/12/07

### **1. Update of the TDS & Chloride Sampling Project**

To fulfill the EPC directive to “Sample and monitor chlorides and TDS for adequate data to make an informed decision including the possible costs and returns associated with clean and healthy water”, the IDNR Monitoring Section conducted the TDS/Chloride wastewater study from August 23<sup>th</sup> through October 12<sup>th</sup>, 2005 during low stream flow conditions. The goal of the project was to accurately and objectively assess the ion and TDS concentrations in the effluent of point source facilities, upstream and the downstream of the outfall.

The sampling was conducted for approximately 100 of Iowa’s point source facilities that potentially have elevated levels of TDS & Chloride and their respective receiving streams. Daily samples were taken at three to five locations depending on the wastewater treatment type and whether the point source is discharging. The locations included: a city tap water sample, a site in the stream upstream of the discharge location, a grab sample of the discharge, a 24-hour composite of the discharge, and a site downstream of the discharge. The cities were selected through a joint effort between IDNR and the IWPCA.

The results show that for the selected 100 facilities that potentially have elevated level of effluent TDS and chloride, the downstream TDS and chloride concentrations were usually below the threshold levels (TDS threshold of 1000 mg/l, chloride threshold level of 230 mg/l).

### **2. Potential Fiscal Impacts**

The estimated facilities that have effluent chloride levels above the potential chronic criterion could be over one hundred. However, some of them may achieve enough dilution in the receiving stream to be able to meet the proposed limits. The categories of facilities that could be impacted are municipal wastewater treatment plants with hard water supplies, water treatment plants, and food processing plants.

The economic impact of TDS on point source discharges depends on the approach that the Department will take on TDS criterion. If a numerical criterion of 1000 mg/l is adopted, the number of impacted facilities could be several hundreds. These facilities could include municipal wastewater treatment plants with hard water supplies, water treatment plants, food processing plants, ethanol plants, industrial process and cooling water including power plants. However, if the current TDS site specific criteria are replaced with specific ion criteria such as chloride and sulfate, the number of impacted facilities would be almost the same as the number of facilities that are impacted by the potential chloride criteria.

The possible fiscal impacts will also be directly related to the planned implementation approach of the new criteria. Compliance with water quality-based permit limits for NPDES may potentially be achieved in multiple ways. The possibilities range from source reduction (low cost) to treatment technologies (high cost). Alternative implementation approaches to assess compliance is dependent on the criteria that is proposed, but can possibly include toxicity testing and flow-variable limits.

These possibilities will be explored in greater detail later in the criteria development and fiscal analysis process.

Treatment technologies available for TDS/Cl include the following:

- Source reduction: may not be feasible in some cases
- Reverse osmosis technology: costly, need to determine how to handle the waste stream
- Thermo method: evaporation, costly
- Chemical precipitation: usually used for metals
- Integrated membrane/recycling methods: the final solids are removed by a crystallizer and the effluent used results in zero discharge.

TDS reduction should start from control – prevent TDS from entering the water system in the first place. If source reductions are not possible, technological advancements may be required to remove TDS. The most widely used TDS removal technique is reverse osmosis, including single reverse osmosis operation, and integrated membrane/recycling methods. The latter are mostly used in the pilot test phase. All other methods are relatively new, and either in research stage or only apply in specific sites and settings.

Steps to determine fiscal impacts:

- (1) Obtain the total number of facilities that could potentially have high TDS and chloride effluents;
- (2) Eliminate the percentage of facilities that could get enough dilution to meet the in-stream chloride criterion. The percentage could be calculated using the monitoring results from one hundred selected facilities during 2005 IDNR TDS/chloride study;
- (3) Obtain the total number of facilities that could cause the in-stream chloride levels above the potential chloride criterion;
- (4) Figure out the total cost based on the total number of facilities from Step (3) and TDS/chloride treatment cost per facility.

### **3. TDS Overview and Issues**

Total Dissolved Solids (TDS) is a measure of all constituents dissolved in water including inorganic salts, organic matter and other dissolved materials in water. The principal inorganic anions dissolved in water include carbonates, chlorides, sulfates and nitrates. The principal cations are sodium, potassium, calcium and magnesium. Many of these ions are essential nutrients to aquatic organisms and may normally be present in source and receiving water. However, natural and anthropogenic sources can increase ion concentrations to levels toxic to aquatic life.

The potential high TDS sources include industrial process wastewater such as ethanol plants, water treatment plant effluent, municipal wastewater discharges, geology & soil in the watershed, and agricultural runoff.

TDS causes toxicity through increases in salinity, changes in the ionic composition of the water and toxicity of individual ions. Increases in salinity have been shown to cause shifts in biotic communities, limit biodiversity, exclude less-tolerant species and cause acute or chronic effects at specific life stages. The most recent data have shown that the individual ions that comprise TDS may have more influence on toxicity than can be estimated through gross measurements such as

TDS. Research found that the presence of multiple cations tended to be less toxic than comparable solutions with only one cation. Also, as the hardness increases, the TDS toxicity may decrease.

The TDS concentration that causes adverse effects varies substantially with the ion composition. For example, the TDS lethal concentration that causes 50% mortality for an invertebrate species (*Ceriodaphnia dubia*) during 48-hour tests ranges from 390 mg/l to over 4,000 mg/l depending on the ion composition. Studies have shown that, in general, for freshwaters the relative ion toxicity was  $K^+ > HCO_3^- = Mg^{2+} > Cl^- > SO_4^{2-}$ .  $Ca^{2+}$  and  $Na^+$  did not produce significant toxicity. To freshwater organisms,  $Mg^{2+}$ ,  $HCO_3^-$ , and  $K^+$  were the most toxic, generally causing acute toxicity at less than 1,000 mg/l.

One of the difficulties in developing TDS criteria is that there are no national criteria or toxicity database available.

Since TDS toxicity depends on the ion composition, it is recommended that different limits for individual ions, rather than TDS, be used. The State of Illinois is in the process of rule making that replaces the TDS criterion of 1000 mg/l with sulfate criteria (a chloride criterion of 500 mg/l is already in the rules). The challenge is what specific ion criteria should be used to replace TDS. Among the potentially most toxic ions,  $K^+$ ,  $HCO_3^-$ ,  $Mg^{2+}$ ,  $Cl^-$  and  $SO_4^{2-}$ , the effluent concentrations for the first three ions are usually relatively low (based on ion analysis data submitted to IDNR by permitted facilities, the effluent  $K^+$ ,  $HCO_3^-$ ,  $Mg^{2+}$  concentrations are usually less than 100 mg/l, 500 mg/l and 100 mg/l, respectively). Also, no adequate toxicity data are available to derive the criteria for these ions. The only national criterion available for ions is chloride. It is possible the TDS criteria could be replaced with chloride and sulfate ion criteria. This is the approach that State of Illinois is taking with the EPA Region 5 support.

The department is in the preliminary stages of criteria development and is actively working on developing the TDS and Chloride Issue Paper. The department plans to meet with a technical advisory committee (TAC) to determine the best approach to revising TDS and chloride criteria and developing the specific criteria. Once acceptable criteria have been developed, the department will officially begin the rule making process, beginning with an EPC informational item (possibly Fall 2007).

**EPC Recommendations Analysis  
per ARC 3281B**

1. Sample and monitor chlorides and TDS for adequate data to make an informed decision including the possible costs and returns associated with clean and healthy water.

**Progress Report:**

**The department conducted a large coordinated monitoring study to sample chloride and TDS, among a host of other parameters with purpose of determining an informed and accurate assessment of potential fiscal impacts. The department is actively working towards completing this assessment.**

2. Monitor aquatic ecosystem impacts through biological surveys. Particularly where aquatic life may be impacted as a result of current effluent levels of cations and anions. Coordinate with and utilize fisheries personnel where possible.

**Progress Report:**

**The department does perform regular biological surveys of Iowa's waters. These surveys can reveal undesirable biological situations where aquatic life may be impacted; however determining what is causing the impact is difficult. A multitude of factors can contribute to an impact such as low flows, temperature, lack of available habitat, diversity of habitat, and other chemical pollutants in addition to the cations and anions of TDS.**

**The state does not have any waters currently impaired for TDS and/or chloride. The monitoring study discussed above may help us pinpoint areas of the state that may have the potential to cause such an impairment, but that has yet to be determined.**

3. Utilize the EPA to make sure options being considered are consistent with the Federal Clean Water Act including court directives.

**Progress Report:**

**The department has informed EPA on multiple occasions of the options considered as is working actively towards criteria that are consistent with the CWA. Meetings are scheduled for March 2007 to discuss progress on the development of new criteria.**

4. Review stream classifications to be sure that the uses of streams are properly classified.

**Progress Report:**

**The department is actively working on completing UA/UAA's for Iowa's perennial streams that receive a continuous discharge from an NPDES permitted facility. This progress will continue into the future and is a department priority.**

5. Sponsor a workshop with help from EPA and Iowa scientists on alternative solutions to hard water, solutions for managing effluent during low flow conditions, new technology in waste treatment, and health considerations of effluent when reentering the drinking water supply.

**Progress Report:**

**This recommendation is broader than just managing TDS and Chloride but delves deeply into implementation processes. This response will focus solely on the issue of TDS and Chloride criteria development.**

**The department understands that there are minimal options for the treatment of TDS and Chloride and will be working actively towards solutions during criteria development. First, the fiscal impact of the proposal will need to be determined. At that point, the department should have a better understanding of whom and how many facilities will be affected which can be used to determine if this workshop is necessary. Also, there is potential for alternative implementation methods that may include a phased compliance approach ranging from best management practices to facility upgrades. The necessity of the workshop can also be dictated by the department's implementation approach. In conclusion, more information during the criteria development process is needed to determine if a workshop is appropriate.**

6. Continue consideration of site specific WET tests but with maximum standards to protect aquatic ecosystems, livestock and wildlife watering and other uses in current rules.

**Progress Report:**

**The current implementation of the site specific TDS toxicity testing approach (triggered by elevated TDS and Chloride values ) as a general criterion is to ensure appropriate protection of multiple beneficial uses including but not limited to aquatic life, livestock watering, crop irrigation, and other incidental water withdrawal uses.**

**It should be noted that the NPDES program is currently evaluating the toxicity testing element of NPDES permitting with plans to potentially broaden its scope consistent with EPA guidance. This may be the avenue where regular WET testing occurs as opposed to site-specific testing triggered by elevated TDS and Chloride values.**